Chapter 17 The Endocrine System, Part 1

1. An overview of hormones and the endocrine system
2. Describe the structural and functional organization of the hypothalamus and the pituitary and explain their relationship
3. Discuss the locations and structures of the thyroid and parathyroid glands.
4. List the hormones (and their function) produced by these glands.
5. Briefly review some examples of abnormal hormone production

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LAS POSITAS COLLEGE

Endocrine System Overview

- Ductless glands produce hormones
- Secreted directly into the bloodstream (endocrine)
  - Except the thyroid
- Gland may be entire organ:
  - Pituitary, thyroid, parathyroid, pineal, adrenal
- or bits of tissue interspersed within an organ
  - Gonads, kidneys, many others

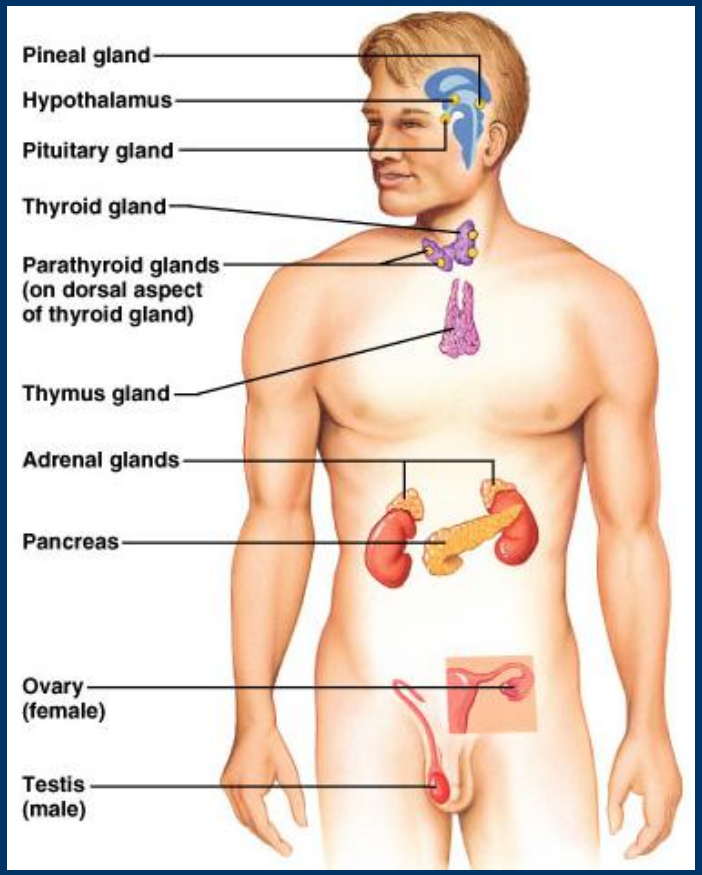
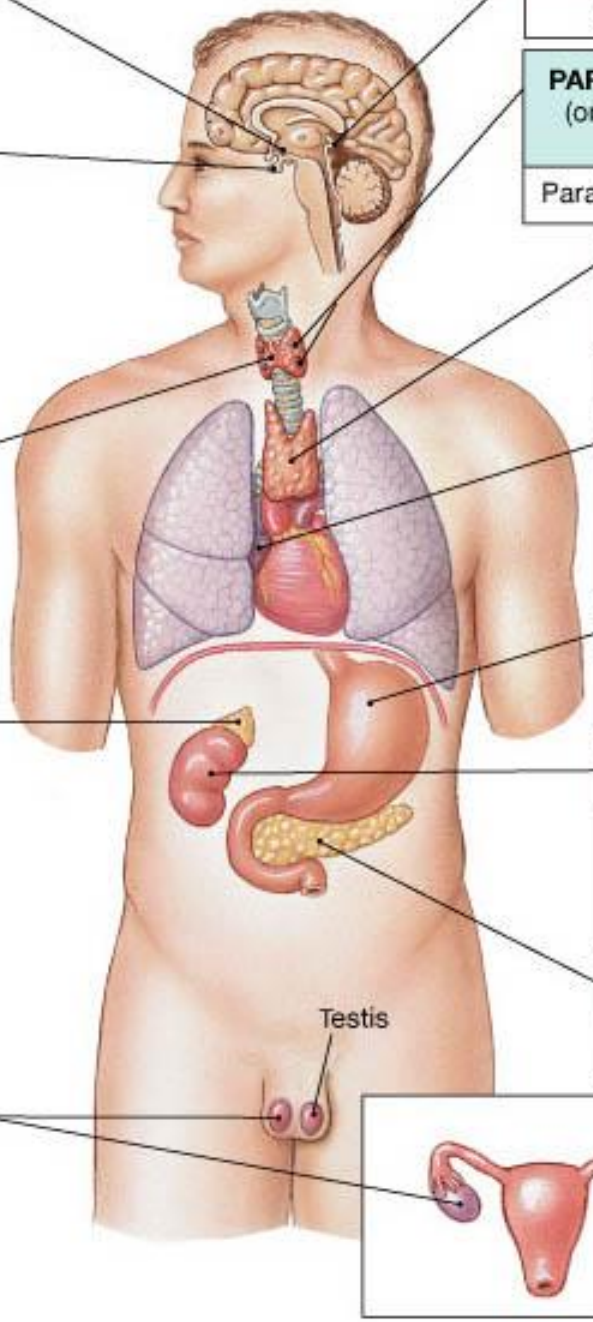


Fig 17.1



HYPOTHALAMUS

Production of ADH, oxytocin, and regulatory hormones

PITUITARY GLAND

Anterior lobe:
ACTH, TSH, GH, PRL, FSH, LH, and MSH
Posterior lobe:
Release of oxytocin and ADH

THYROID GLAND

Thyroxine (T_4)
Triiodothyronine (T_3)
Calcitonin (CT)

ADRENAL GLANDS
(cap each kidney)

Medulla:
Epinephrine (E)
Norepinephrine (NE)
Cortex:
Cortisol, corticosterone, aldosterone, androgens

GONADS

Testes (male):
Androgens (especially testosterone), inhibin
Ovaries (female):
Estrogens (especially estradiol), progestins, inhibin

PINEAL GLAND

Melatonin

PARATHYROID GLANDS
(on posterior surface of thyroid gland)

Parathyroid hormone (PTH)

THYMUS
(Undergoes atrophy during adulthood)

Thymosins

HEART

Atrial natriuretic peptide (ANP)
Brain natriuretic peptide (BNP)

DIGESTIVE TRACT

Numerous hormones *(detailed in Chapter 25)*

KIDNEY

Erythropoietin (EPO)
Calcitriol

PANCREATIC ISLETS

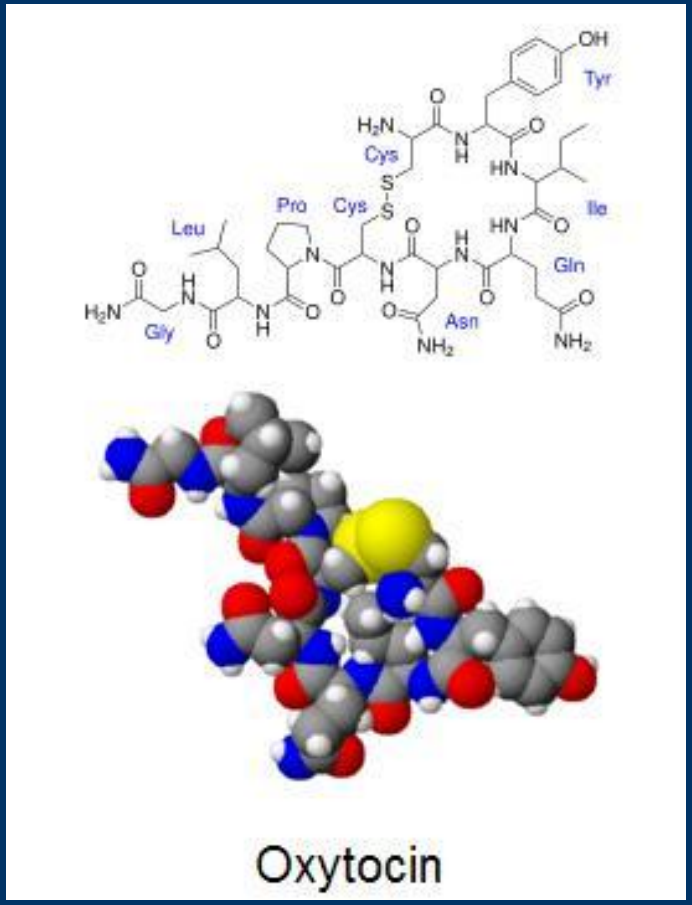
Insulin, glucagon

KEY TO PITUITARY HORMONES:

ACTH	Adrenocorticotropic hormone
TSH	Thyroid-stimulating hormone
GH	Growth hormone
PRL	Prolactin
FSH	Follicle-stimulating hormone
LH	Luteinizing hormone
MSH	Melanocyte-stimulating hormone
ADH	Antidiuretic hormone

Classes of Hormones (p 516)

- Chemical classification of hormones
  - Amino Acid Derivatives
    - Proteins (longer)
    - Peptides (shorter)
    - Amines (derived from a single amino acid)
  - Steroids (from cholesterol)
    - Glucocorticoids, mineralocorticoids, sex hormones
  - Eicosanoids (from arachidonic acid)
- Target tissues are identified by specific receptors (on target cells). The effects may be stimulatory or inhibitory, depending on the receptors.



Oxytocin

Control of Hormone Secretion

- Humoral
  - BP and the kidney's JG apparatus
- Neural
  - Recall the adrenal medulla
  - Hypothalamic Releasing Factors
- Hormonal
  - Pituitary Releasing Hormones, e.g., FSH

Hypothalamus

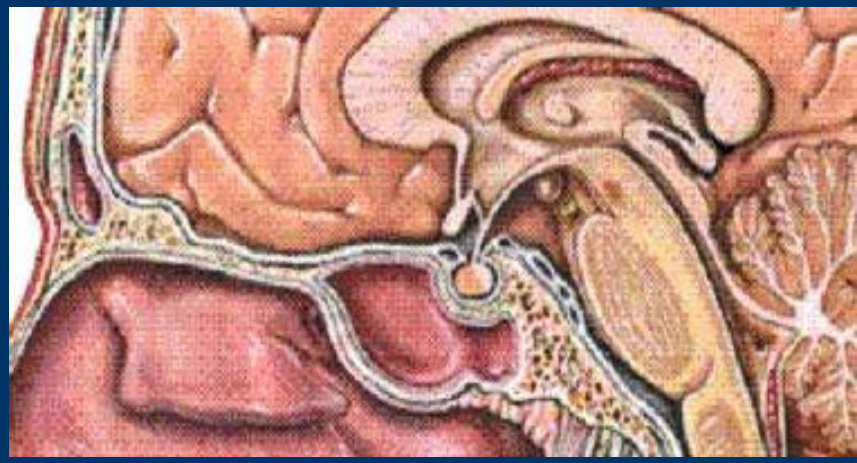


Fig 17.3

Control Center for internal environment

Regulates nervous and endocrine systems via 3 mechanisms:

1. **ANS centers exert nervous control on adrenal medulla**
2. **ADH and Oxytocin production**
3. **Regulatory hormone production (RH and IH) controls pituitary gland directly and all other endocrine glands indirectly**
    1. **These regulatory hormones are released from neurons, thus we have neuroendocrine cells.**

Pituitary Gland (= Hypophysis) p 518

- **Structure:**
  - Located at the base of the brain, surrounded by the Circle of Willis
  - Infundibulum - connection to hypothalamus
  - In the sella turcica of the sphenoid bone
  - Two parts with separate embryonic origins:
    - Anterior Pituitary
    - Posterior Pituitary

The flavor of the nomadic
tradition is captured in this ornate
saddle from Turkey which was
presented to President Theodore

Pituitary Gland (= Hypophysis) p 518

- Anterior Pituitary (= adenohypophysis)
  - AKA pars distalis
  - production of 7 peptide hormones
    - 4 are tropic hormones, stimulating other endocrine glands
  - Pars intermedia and pars tuberalis secrete MSH and some gonadotropins.

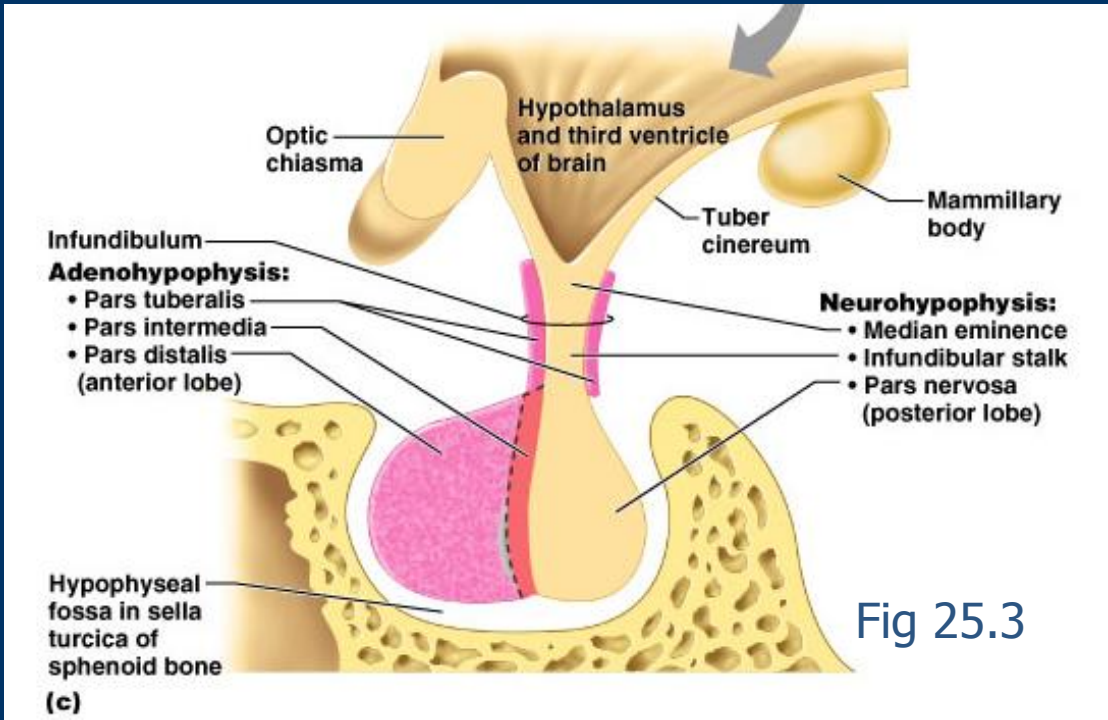


Fig 25.3

Pituitary Gland (= Hypophysis) p 518

- Posterior Pituitary (= neurohypophysis)
  - AKA pars nervosa
  - Storage reservoir for ADH and Oxytocin (produced in ?)

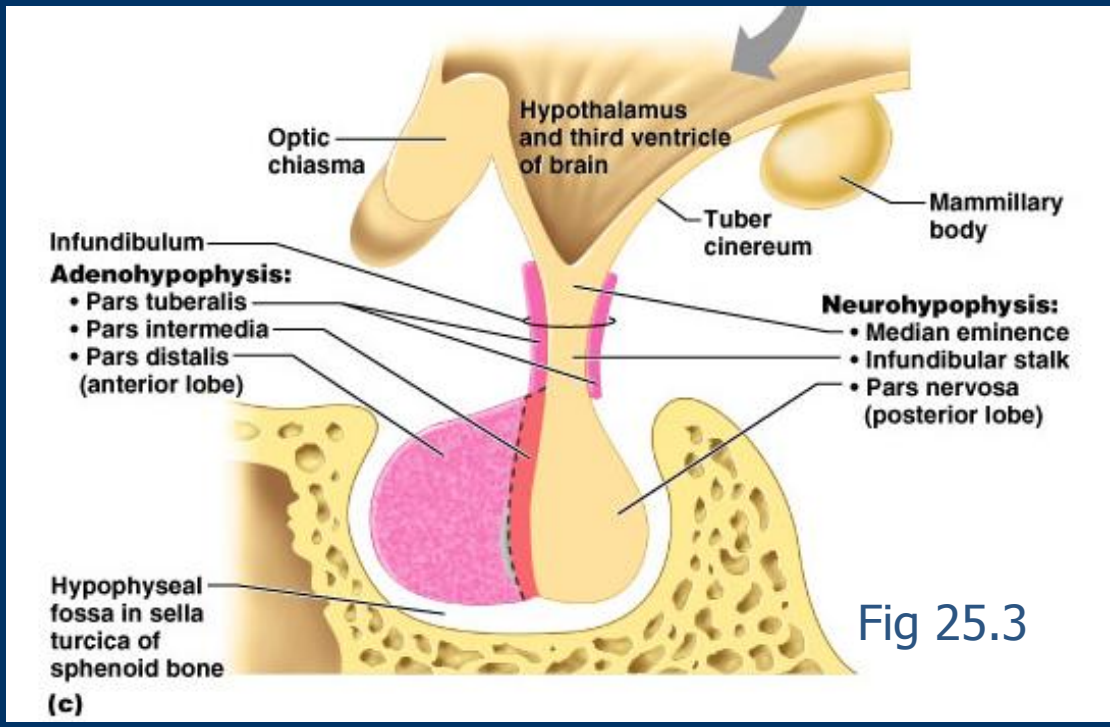
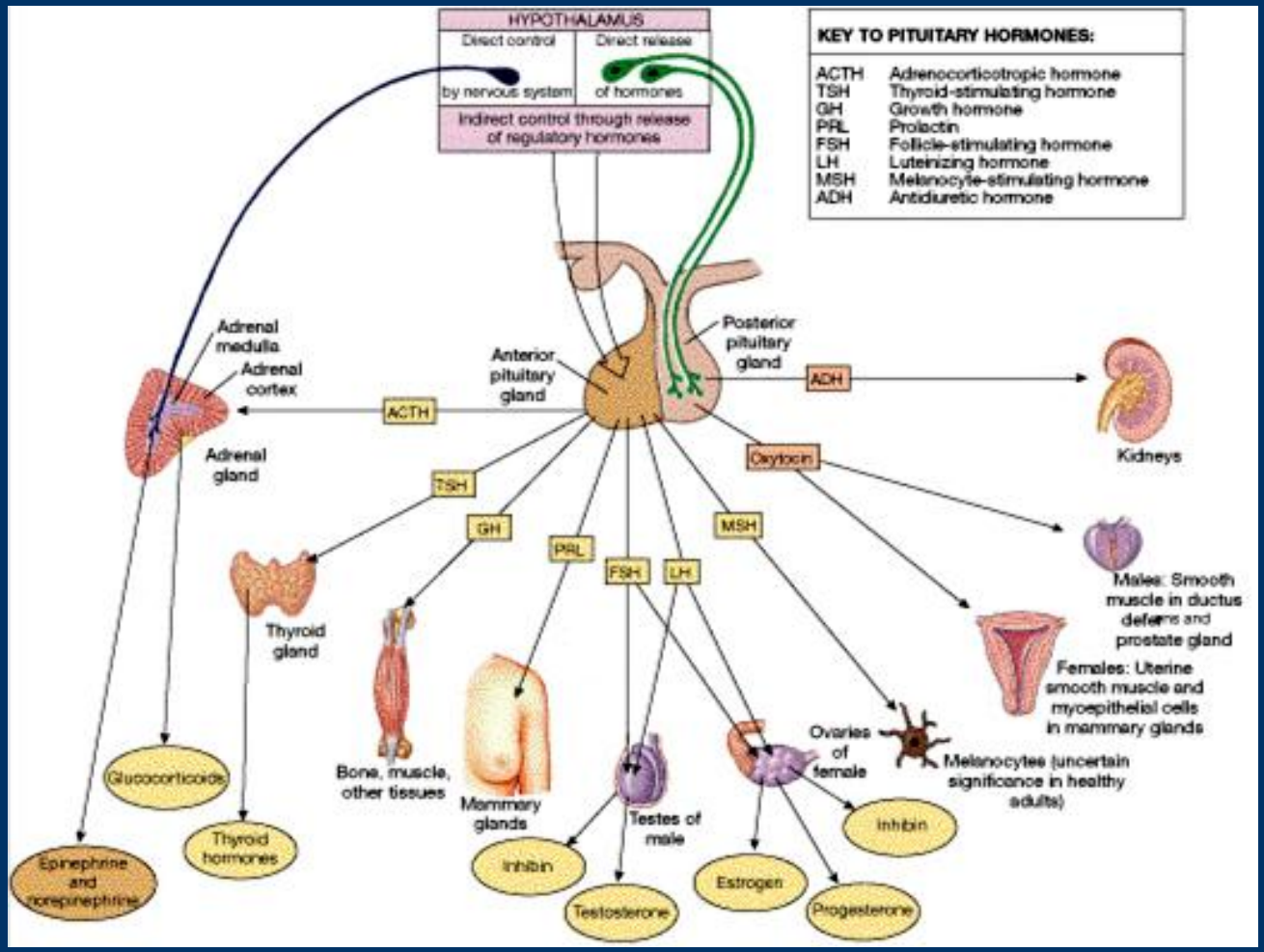


Fig 25.3

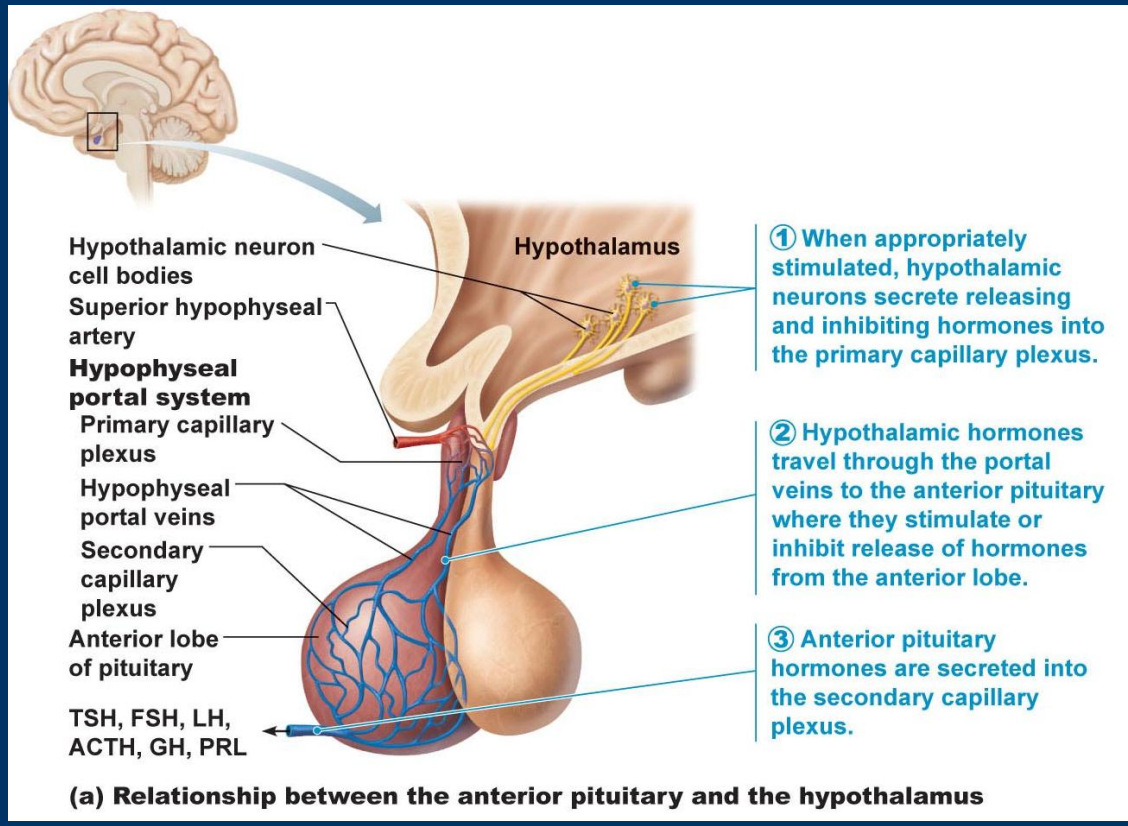
Pituitary Gland (= Hypophysis)

Review Table 25.1



Anterior Pituitary: Portal System

- Portal systems: two capillary networks in serial arrangement
- Three sites of capillary portal systems: liver, kidney, and pituitary
- Portal veins: blood vessels that link two capillary networks


Hypothalamic neuron cell bodies
Superior hypophyseal artery
Hypophyseal portal system
Primary capillary plexus
Hypophyseal portal veins
Secondary capillary plexus
Anterior lobe of pituitary
TSH, FSH, LH, ACTH, GH, PRL
Hypothalamus
① When appropriately stimulated, hypothalamic neurons secrete releasing and inhibiting hormones into the primary capillary plexus.
② Hypothalamic hormones travel through the portal veins to the anterior pituitary where they stimulate or inhibit release of hormones from the anterior lobe.
③ Anterior pituitary hormones are secreted into the secondary capillary plexus.
(a) Relationship between the anterior pituitary and the hypothalamus

Control of the Anterior Pituitary

- Hypothalamus has neurons that produce
  - Releasing , e.g., GnRH, or
  - Inhibiting Hormones
- Into the first capillary plexus
- Down the infundibulum in portal veins
- Into the second capillary plexus
  - Receptors in pituitary
- Hormones then released into the circulation

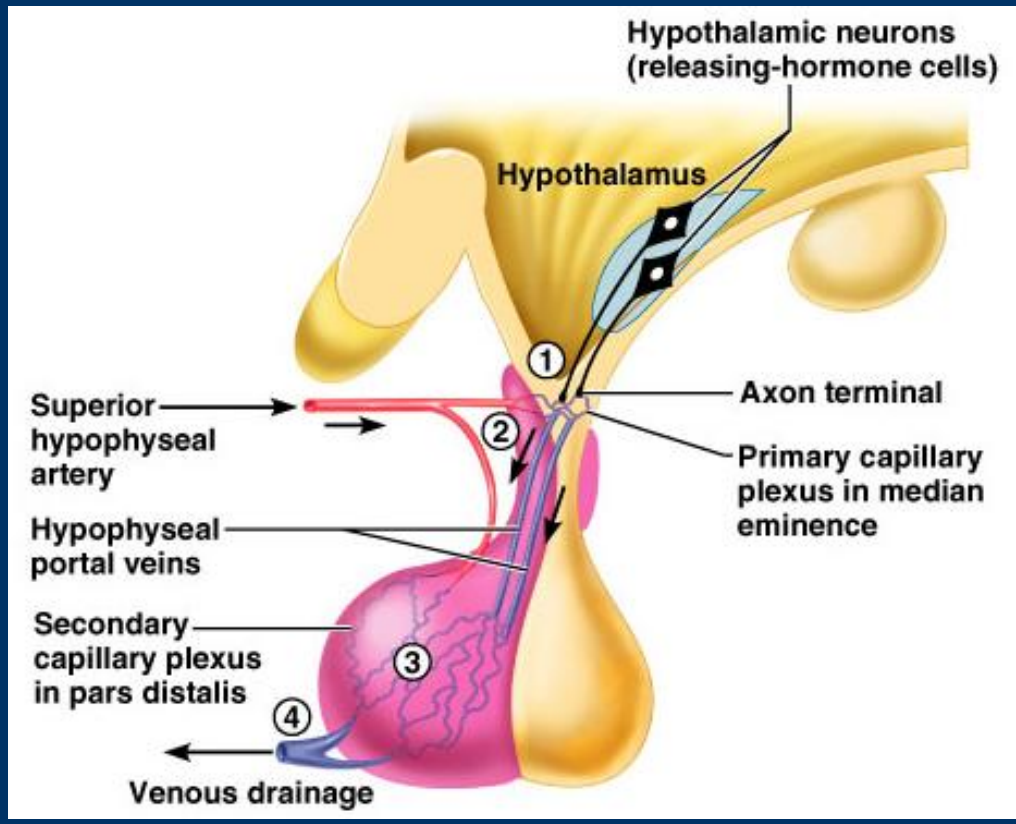


Fig 17.4 (a)

Neurohypophysis = PP

- Neurons originate in the Supraoptic and Paraventricular Nuclei
- Their axons extend down the infundibulum
- Release Oxytocin and ADH (vasopressin) into the circulation

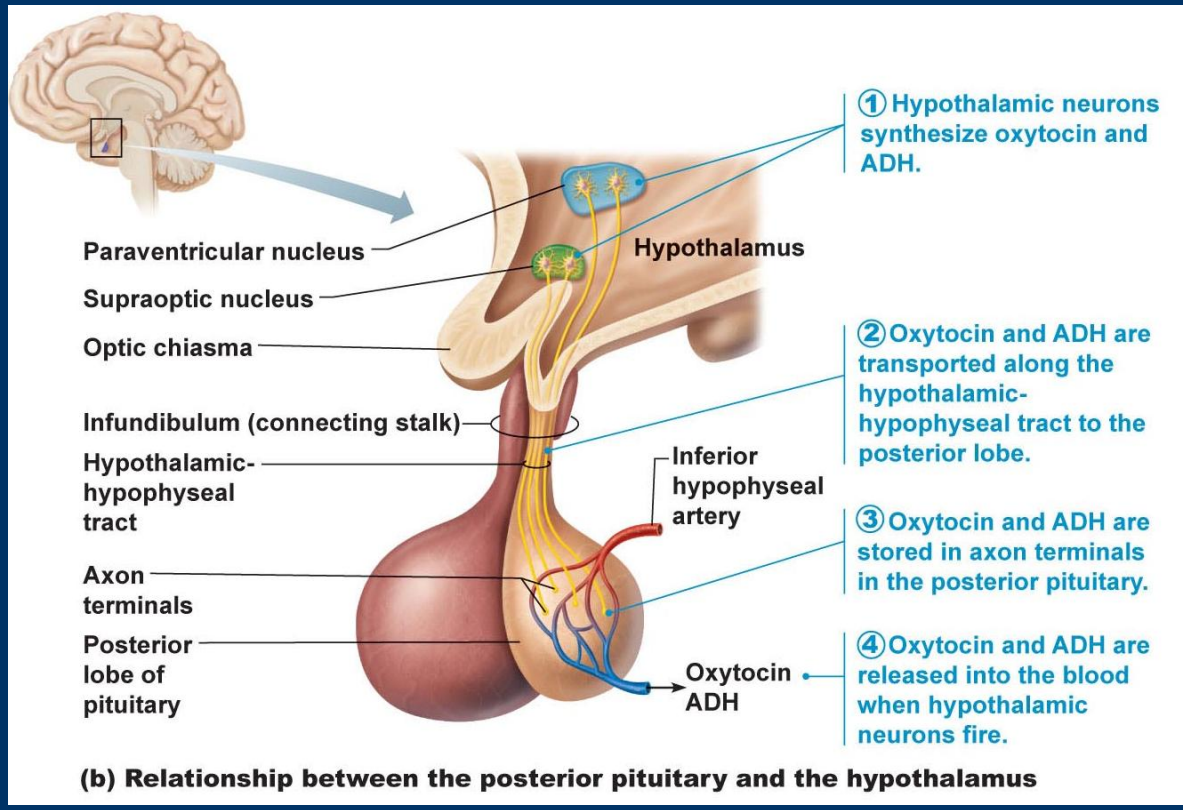
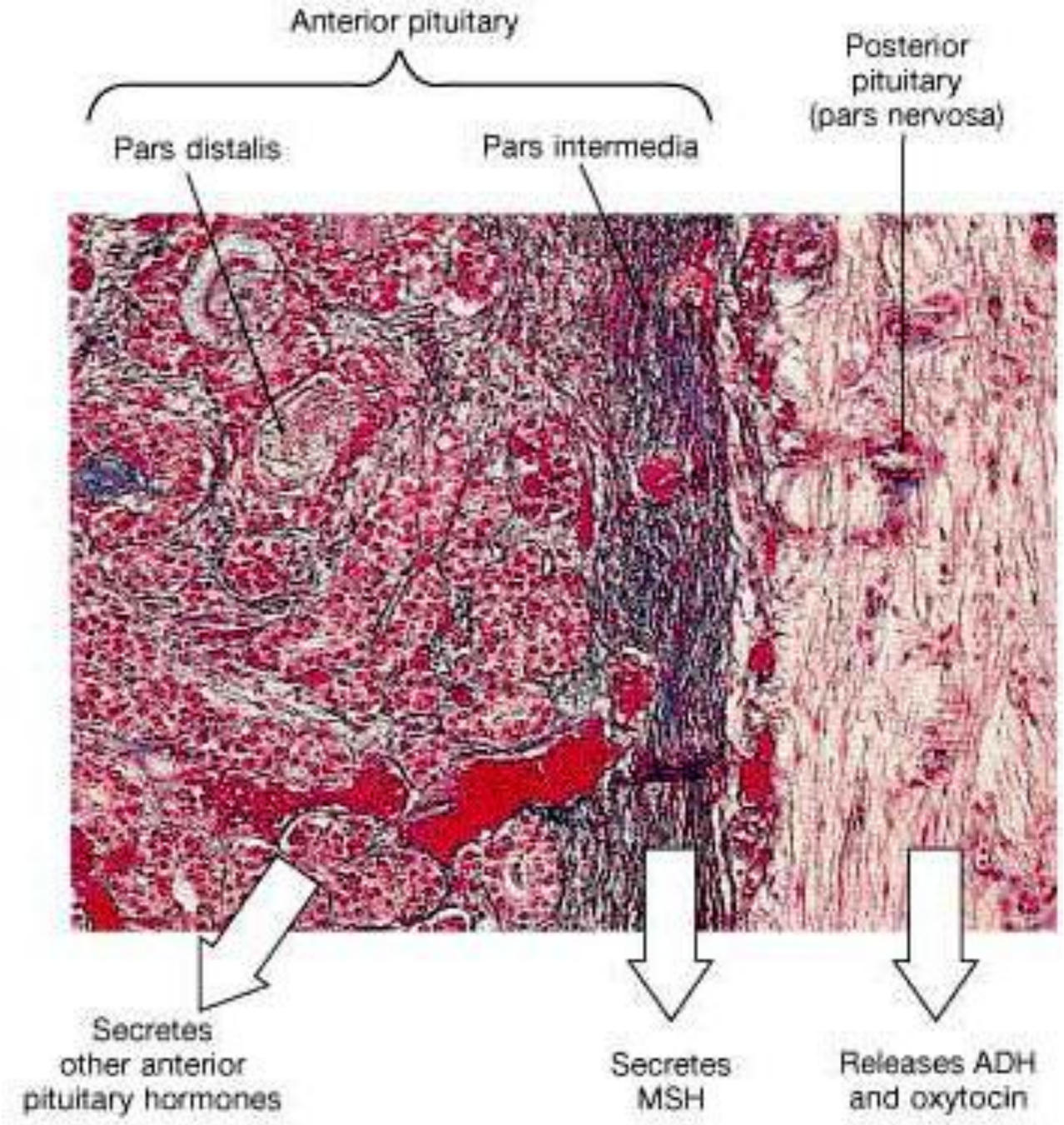
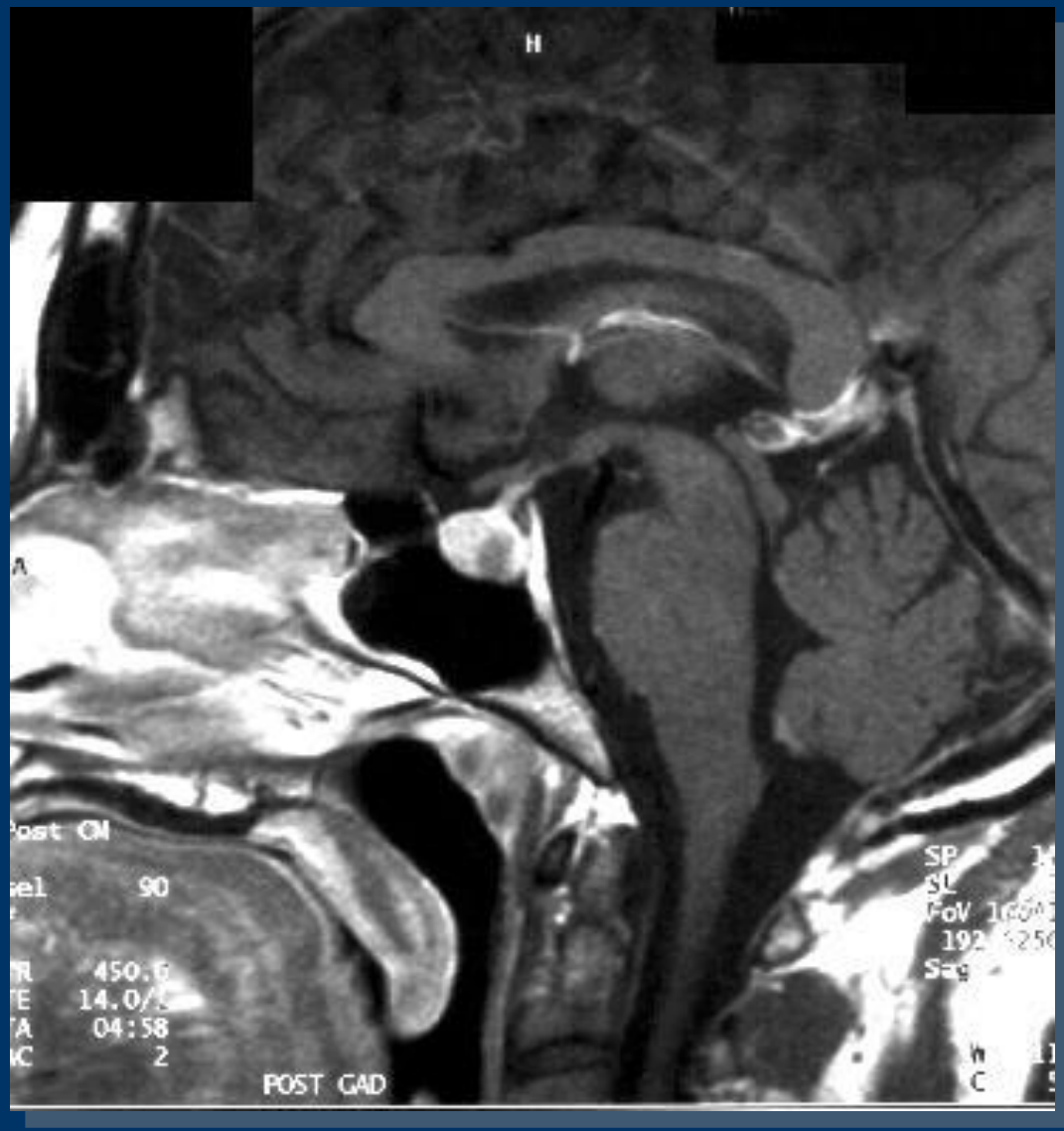

Paraventricular nucleus
Supraoptic nucleus
Optic chiasma
Infundibulum (connecting stalk)
Hypothalamic-hypophyseal tract
Axon terminals
Posterior lobe of pituitary
Hypothalamus
Inferior hypophyseal artery
Oxytocin
ADH
① Hypothalamic neurons synthesize oxytocin and ADH.
② Oxytocin and ADH are transported along the hypothalamic-hypophyseal tract to the posterior lobe.
③ Oxytocin and ADH are stored in axon terminals in the posterior pituitary.
④ Oxytocin and ADH are released into the blood when hypothalamic neurons fire.
(b) Relationship between the posterior pituitary and the hypothalamus

Fig 17.4 (b)



(b) Anterior and posterior pituitary tissues (LMx77)

Pituitary MRI, contrast enhanced



Thyroid Gland p 523

- Anterior surface of trachea just inferior of thyroid cartilage (or Adam's apple)
- Two lobes connected by isthmus

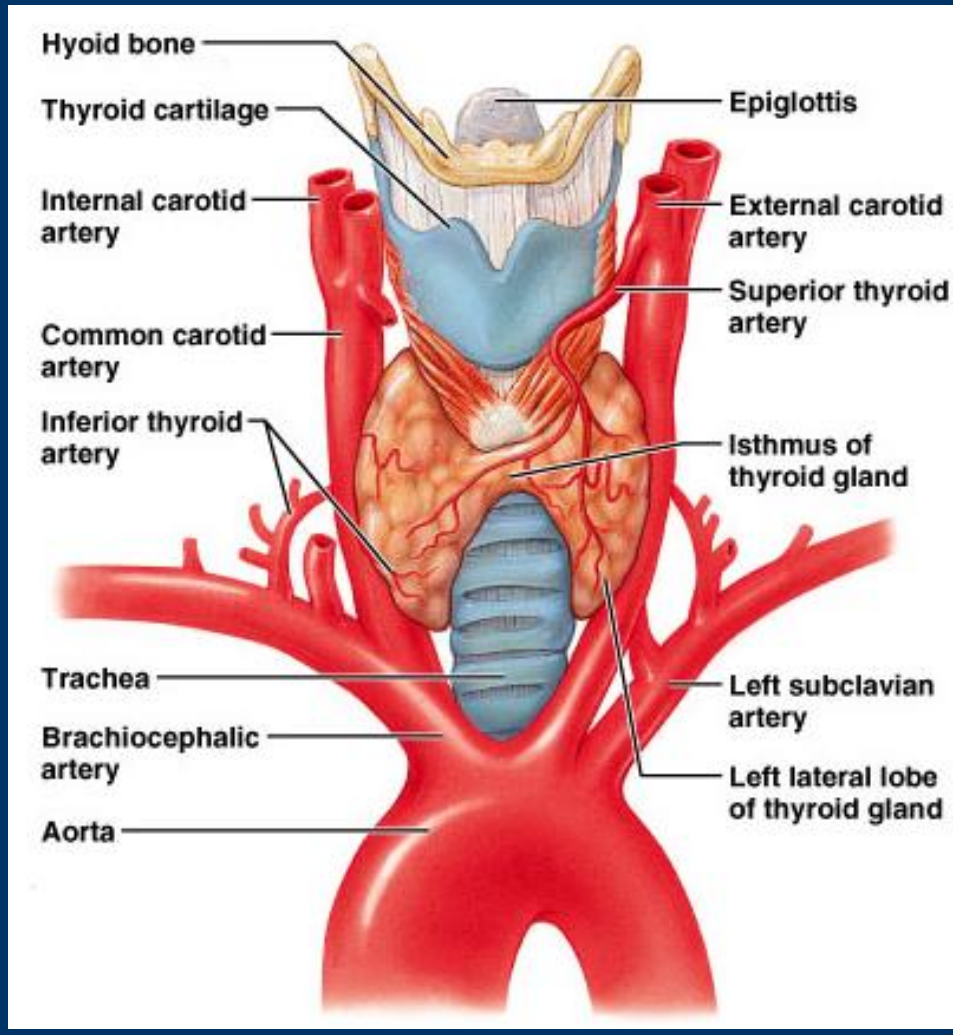
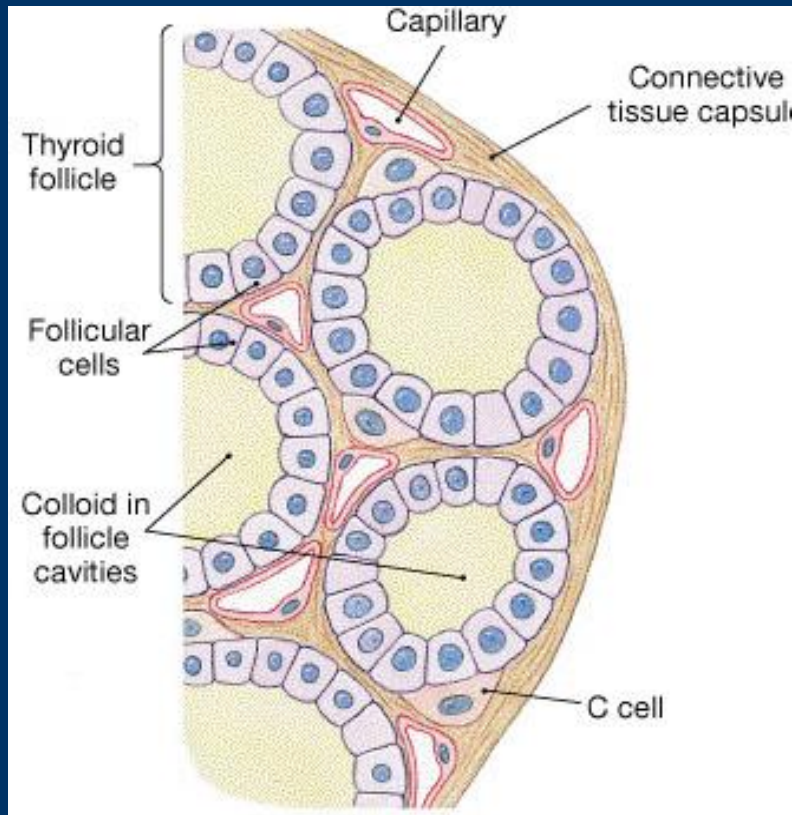


Fig 17.5

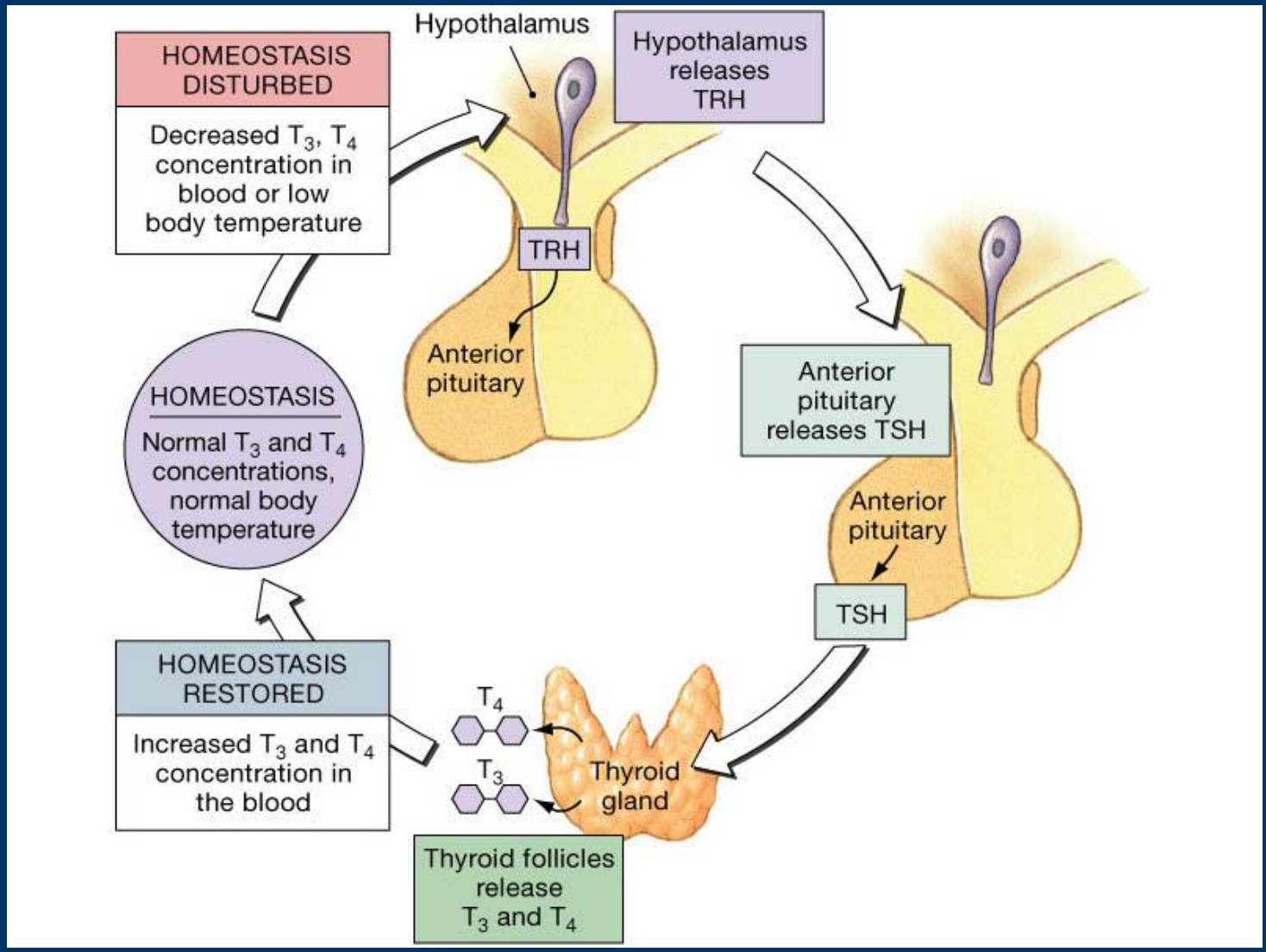
More Thyroid

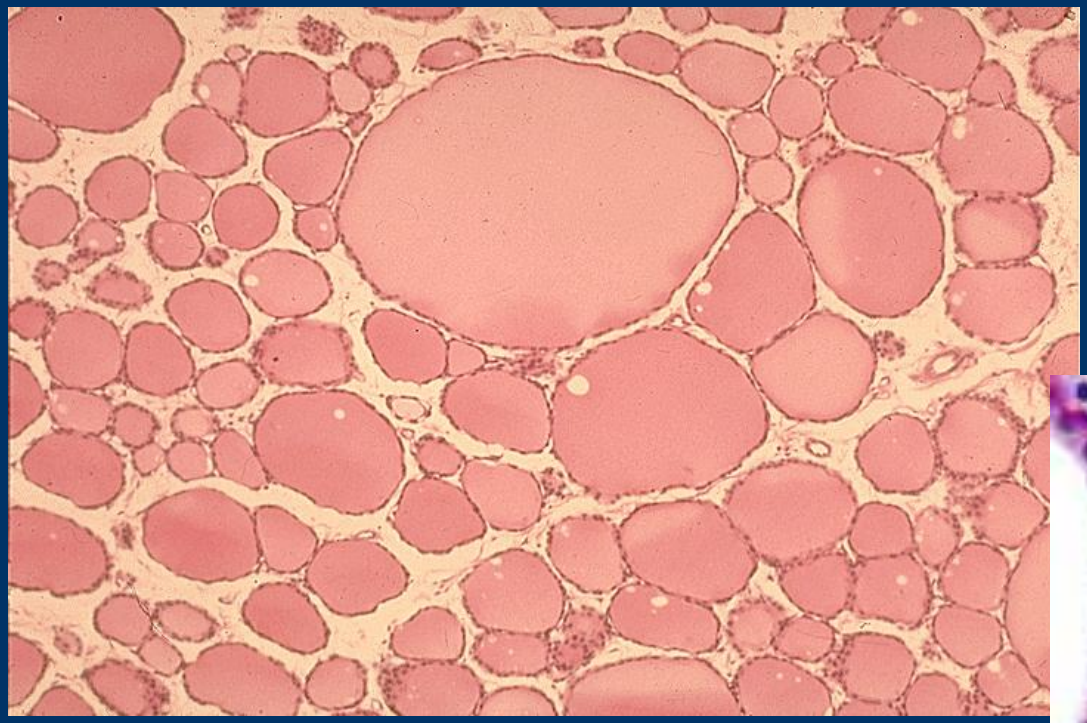
- Thyroid follicular cells (simple cuboidal epithelium) produce and store thyroglobulin in thyroid follicles
  - Iodine then added to produce thyroxine (T_4) and triiodothyronine (T_3) inside the follicles
  - The thyroglobulin is reabsorbed by the follicular cells, cleaved, and the thyroid hormone (T3 and T4) are released into the bloodstream
  - Note that this is the only extracellular storage of hormones
- C (chief) Cells: (AKA parafollicular cells) produce calcitonin
  - Interspersed between thyroid follicles
  - Lower blood Calcium



(c) Thyroid follicles (LM × 260)

Classic Negative Feedback Loop





C-Cells

Simple cuboidal epithelium

Thyroid Disease

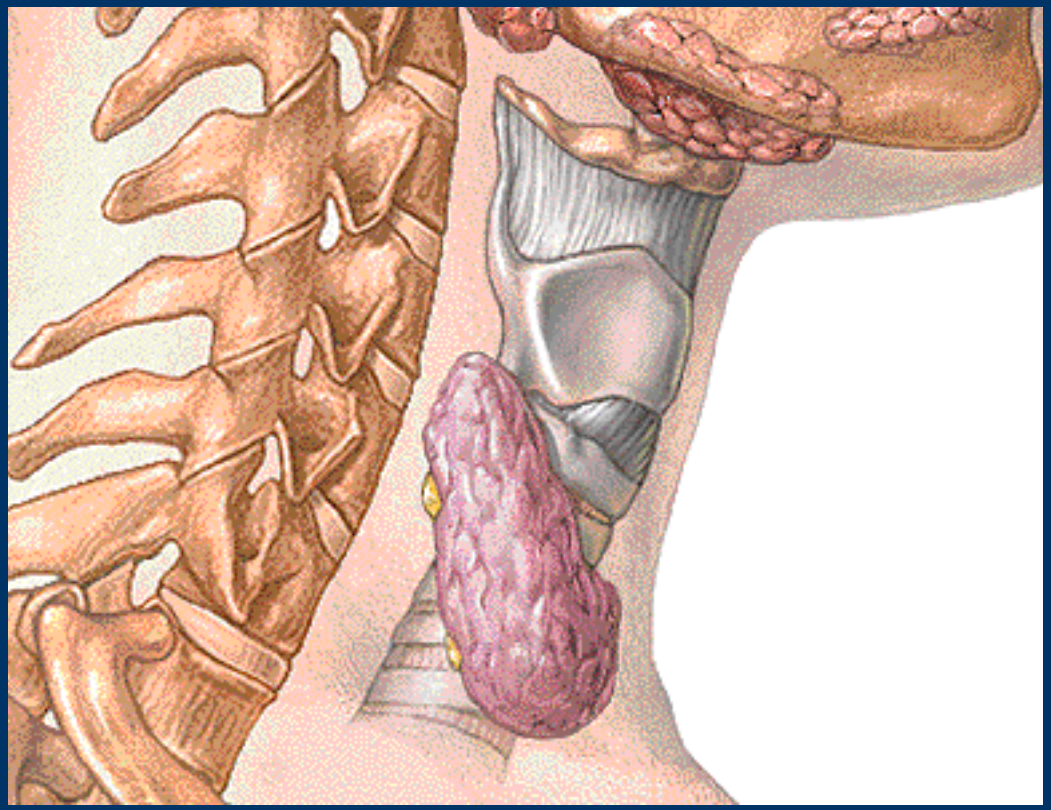
- Hyper-
  - Cardiovascular
    - Increased BP
    - Tachycardia
    - Palpitations
  - Neuromuscular
    - Emotional lability
    - Insomnia
    - Weakness
    - Hand Tremor

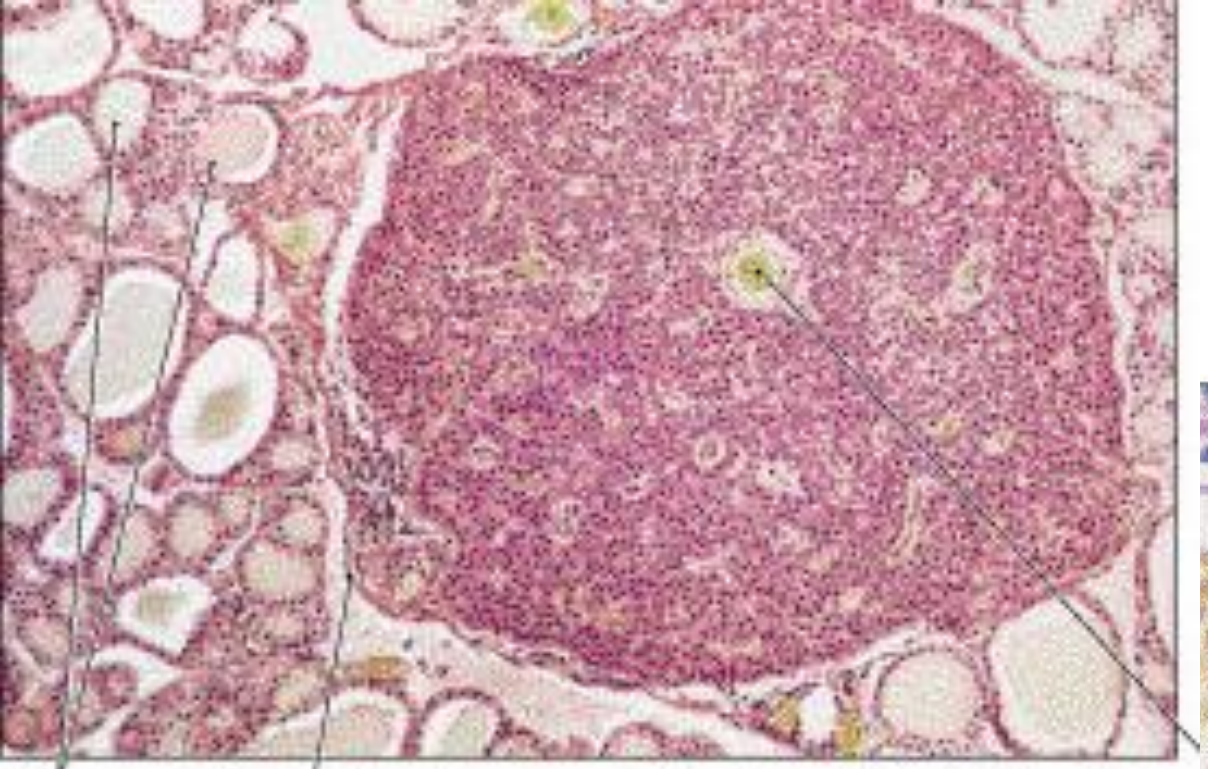
- Hypo-
  - Weakness
  - Dry, coarse Skin
  - Lethargy, Slow Speech
  - Feel cold
  - Less Sweat
  - Eyelid and Facial Edema

Parathyroid Glands

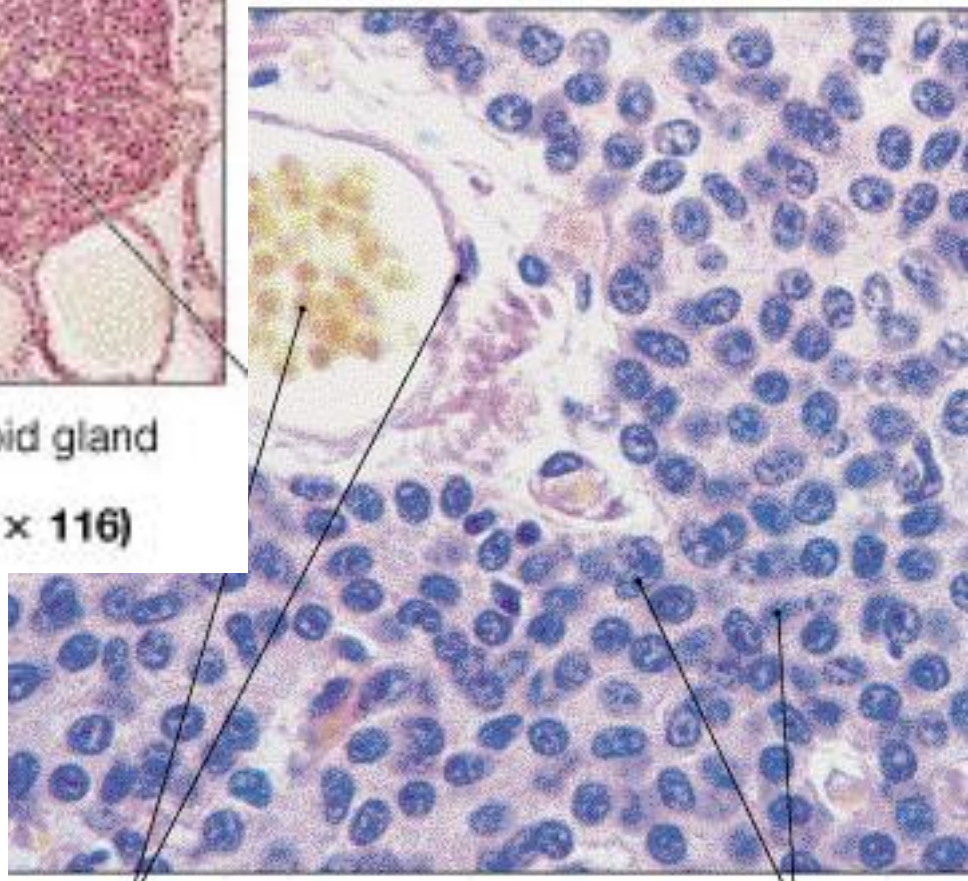
4 tiny glands embedded in the posterior aspect of the thyroid (superior and inferior)

- Parathyroid hormone (PTH; sometimes also called parathormone)
- Function:
  - raises blood [Ca^{2+}]
  - antagonist to Calcitonin





(b) Thyroid and parathyroid tissues (LM × 116)



(c) Parathyroid gland (LM × 850)